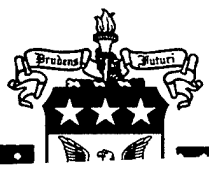
STRATEGY RESEARCH PROJECT

THE REVOLUTIONIZED WARFIGHTER CIRCA 2025

BY

BARBARA A. JEZIOR
Department of the Army Civilian



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USAWC Strategy Research Project

THE REVOLUTIONIZED WARFIGHTER CIRCA 2025

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Barbara A. Jezior

Dr. Douglas V. Johnson II
Project Advisor

U.S. Army War College
Carlisle Barracks, Pennsylvania 17013

ABSTRACT

AUTHOR: Barbara A. Jezior

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This paper describes the technical evolution to a dismounted revolutionized Warfighter System by the year 2025. An enormous contributor to dominating maneuver, it will be critical for winning future battles. The technologies described comprise what the warfighter will wear, carry, and consume, and those which will improve, sustainability, survivability, and command and control. The process is the Land Warrior program which promises numerous improvements, especially in the C^4I, arena around the year 2000. The second major building block is the Military Operations in Urban Terrain (MOUT) Advanced Concepts Technology Demonstration which will produce major improvements in weaponry (lethal and non-lethal), C^4I, small unit operations, combat ID, and sniper detection between 2003-2005. The author then outlines technologies achievable by 2025 that either build on MOUT technologies or offer radical breakthroughs. The paper concludes the Warfighter System should be a top military priority and that it merits special developmental structures and procedures.

TABLE OF CONTENTS

The Revolutionized Warfighter circa 2025

Introduction

A Plausible Scenario. *At the end of the 20th century the military decision-makers made some very astute choices. They realized a land force would still be needed in 2025, but also knew the politics and budget realities of the day meant a small force was all they could realistically plan for. They reasoned that if it had to be small, it had to be elite. Simultaneously, the technological advances in command, control, communications, computers, and intelligence (C^4I) of the time were forcing radical changes in warfighting doctrine. This future force would be fighting a war of maneuver, not attrition, and one of the critical elements to dominating maneuver could be a revolutionized warfighter. Since the warfighter would continue to be the common denominator of the spectrum of conflict, they saw no risk in a full-bore investment that would equip the warfighter with every tool possible that could tip the battlefield balance in his or her favor. That foresight twenty-five years ago resulted in today's revolutionized warfighter who is the sine qua non across the globe, and who has proven the wisdom of the earlier investment many times over.*

The 2025 warfighter bears little resemblance to that of the late 20th century. He and his team members are multiply skilled, smart, and more "in charge" than their predecessors. [1,2] *Radically new technologies have also served to make him and her the*

soul of stealth and prowess on the battlefield. They have an arsenal of cutting edge technologies to select from for the battlefield.

One battlefield option is the encapsulated, climate-controlled fighting suit with power enhancements, sophisticated weapons and sensors, a communication and guidance package and active (chameleon-like) camouflage. The power and strength component augment the warfighter's strength by supporting all body forces associated with load carrying. The suit provides situational awareness, operational information and tactical guidance along with small unit medical, logistic and intelligence data.[3]

Another option is a lightweight battle dress uniform that is flexible and body conforming. It improves performance by concentrating vital body heat and blood flow within muscular tissues. It too has the sensors and C^4I capabilities of the first suit described. The compression materials incorporate biological and physical sensors that monitor blood pressure, pulse, body temperature, penetration (from projectiles), blood loss, and other vital signs. It provides friend or foe identification. All the sensors are linked and centralized as appropriate.[4] *He also has cotton-weight ballistic protection and lightweight chemical-biological (CB) gear comprised of a fabric that breathes like regular clothing when no CB agents are present.*

He can also augment his human powers with skinpatch pharmaceuticals tailored specifically for him as the need arises. For example, he can control his fears, have greater powers of concentration, and more physical strength.

He has three-dimensional representation of the battlefield on his arm- or head-mounted display. He can take virtual trips to other parts of the battlefield to see the

action from other vantage points. He has extended sensory powers that are continuing to evolve. Not only can he see everything in human range to include what is obscured by terrain or structures, he will also soon be able to hear and see beyond human range and see the enemy before the enemy sees him. If by any chance the enemy should see and target him first, he has the inner comfort of knowing that the sensors embedded in his clothing would alert the medical world of his exact whereabouts and the seriousness of his wounds.

He can connect to the entire information infrastructure with a tiny system that has filtered incoming data to offset information overload. He gets what he wants when he needs it. His computer system is interactive and has both video and voice functions. Best of all, it is so user friendly that no training was required. It is completely integrated with his other equipment.

The combination of his innate capabilities with radically improved communications and situational awareness, has resulted in flattening the traditional military hierarchy. His team is very small and flexible; its size and structure mission dependent. Both his lateral and hierarchical relationships are a source of support and strength.[5] *He has a level of understanding that far surpasses his level of authority. Every kind of information is his to receive, understand, and assess.*

His weapons are far more lethal and precise. These, combined with the support of the precision indirect fires he knows he can depend on give him immediate target kill. The indirect fires will be on time and on target; there is no more mistaking friend for foe.

Immediate target kill has terrific psychological impacts - a positive one on him, and a negative one on the enemy.

Back to 1997. While the future is murky as to who America's enemies may be and what types of major weapons systems the military will need around 2025, the pundits believe a small, strategic land force is a requirement. This force could be deployed swiftly, serve to deter or halt aggression, and secure any area vital to U.S. interests. The experts also predict a shift from large armies fighting attrition warfare to dispersed, small units fighting maneuver warfare.[6]

Technological advances in the C^4I arena and the correlative changes in doctrine, training and leadership they are forcing also point to that small, elite force as being comprised of multi-functional soldiers[7] or integrated "all arms" combat formations.[8] Either case demands the multi-skilled, very mobile, and independent warfighter, who may be fighting more often in cities and suburbs than on open hills, and who must also be linked to other platforms.[9] This future warfighter will also probably face the asymmetric threats such as those embodied in non-state actors who have no compunctions using CB weapons.

These future warfighters must achieve dominance in maneuver to gain battlefield control and increase their chances for survival. Dominating maneuver can be achieved by moving to distributed and cooperative engagement at the lowest levels and by a technical revolution in soldier capabilities.[10] The small, elite force of the future simply must be as lethal and high-powered as possible, down to the very last warfighter.

As the first Army After Next War Game indicated, "The sine qua non of ground forces in the future is smart, high-quality soldiers who can operate at a very, very fast tempo and in a very sophisticated way."[11]

Technological Stepping Stones to the Warfighter System

What technologies are on the horizon that can meet the materiel needs of such a revolutionized (and assumed joint) force? The emergent technologies are too numerous to count, and this paper will discuss just a few of those relevant to dismounted "Warfighter System." That means those technologies pertaining to any item the dismounted warfighter wears, carries and consumes in a tactical environment. These technologies will improve one or more of the warfighter's capabilities: lethality, survivability, C^4I, mobility, and sustainability.

Many will be taken aback when they first encounter the phrase "warrior system," thinking it dehumanizing. This is not the intent. Only recently has the Army decided to take a systems approach to managing soldier programs the same way it manages major weapons systems. This means the myriad of soldier programs now enjoy centralized oversight, rather than having each commodity developed in a stovepiped, piecemeal fashion. This allows for a fiscally balanced and prioritized soldier "platform" that makes these programs more visible and better able to compete for funding. Most importantly, it also means better, well-integrated equipment.

Land Warrior Program. A revolutionized warfighter will be the result of an evolutionary process, as it is highly unlikely there will be any one program that will develop a whole new set of technologies to replace all warfighter components at a given time.

An ongoing program, the Land Warrior program, could very well be the starting point of this evolution. This program's managers have taken a systems approach to developing warfighter technologies that will result in dramatically new and improved capabilities for the dismounted soldier. Since there has not been much in the way of significant change over the last 50 years for the dismounted segment, there is definitely room for improvement, especially in those areas pertaining to information technology.[12]

By the year 2000 the dismounted world (soldiers and Marines) will begin to see Land Warrior modular fighting systems designed for close combat situations.[13] The basic components are a helmet mounted display, an improved image intensification (I^2) modular weapon, improved protective clothing to include improved modular body armor, a computer and radio set-up, and special software for battlefield communications.

The helmet-mounted computer display is linked directly to the M16 or M4 weapon, which can incorporate other types of weapons and sights. The weapon's thermal sight allows target engagement in daytime, nighttime, around corners and out of a foxhole without exposing its bearer. The computer-based global positioning system (GPS) and radios are mounted on the soldier's back which means voice orders can be replaced with digital orders and transmitted down the chain of command. If a soldier sees something worth reporting, he can also send a digital report through his computer.

The thermal weapons sight, which can see through obscurants like smoke, also makes it possible to transmit a digital still video picture of a battlefield object - such as the enemy! This whole ensemble is in prototype and has been demonstrated.

The system's modularity means the soldier can "mix and match" the various components, depending on mission needs. Another plus is that the total soldier load will be down to 75 pounds. (See Appendix.)

The Land Warrior system will give battalion tactical operations centers better control of the battlespace and the pace of operations. Unit leaders will know where their soldiers are and be able to meet their logistical needs almost instantly.

Military Operations in Urban Terrain (MOUT). Urban warfare is predicted to be a large part of the military future and is a tough challenge in many ways. It also usually involves high costs in both military and civilian casualties.

At this point the capabilities for conducting urban operations are no different now than they were in Vietnam, as fighting in the Balkans is demonstrating.[14] Urban operations have traditionally suffered from poor communications and mobility, difficult command and control (C2), high casualty rates in both the military and civilian communities, and a lack of appropriate training.[15] At present urban fighting also requires large numbers of combat and combat support soldiers.

What urban fighting requires is light, mobile, combatants that are very in tune with their immediate environment (situational awareness), and who have links to outside platforms, such as sensors and fires. It also needs flexible logistical support.

While soldiers fighting in the open have very similar requirements, it becomes a question of degree for a given need. However, the urban world imposes unique difficulties imposed by urban infrastructure and the constant risk of civilian involvement.[16]

There is a joint program underway which will meet many of the requirements for urban fighting and be a major intermediary step toward the revolutionized warfighter(urban or otherwise). This program, the MOUT Advanced Concepts Technology Demonstration (ACTD), will demonstrate its new concepts in 2000 and the resulting materiel should go into full scale development and fielding within three to five years. The individual projects that make up this umbrella program are: [17]

Force XXI Land Warrior

This project adds sophistication to the Land Warrior system previously discussed, such as further advanced individual communications, situational awareness, location, and small arms body armor.

Small Unit Operations

Communications/geo-location, sensors, and situational awareness technologies will be integrated in other battle platforms allowing enhanced C^4I, and sensor to shooter linkages with precise, indirect weapons.

Objective Individual Combat Weapons

This project will produce precision individual weapons having full bursting fire control and either point munitions or airbursting munitions for acquiring targets in defilade (e.g., around corners of buildings). Fire control will be wirelessly linked to C^4I

networks for indirect viewing of targeting data and imagery (on a helmet mounted display) and precise handover of targets to indirect weapons systems.

Combat Identification

Knowing friend from foe will be accomplished by embedded soldier-to-soldier laser interrogation and radio frequency response enabled by sensors and C^4I.

Counter-sniper

The warfighter will have the ability to detect sources of direct fire.

Non-lethal weapons

A suite of non-lethal technologies is being pursued: kinetic impact munitions, distraction devices that will incapacitate, distract or seize individuals, stop vehicles, control crowds, deny areas, and disarm or neutralize equipment.

Multi-purpose Individual Munition.

Researchers are seeking a shoulder-fired weapon that can defeat light armor and targets in masonry structures.

A successful outcome to this ACTD will rewrite individual and small unit operations. The warfighter will be able to move information around the battlefield as needed. This ability translates into precise maneuver and engagement. Everything from firepower to supplies can be delivered when and where needed thanks to a much more sophisticated C^4I network. A warfighter's chances for survival are also greatly increased with the many cutting edge technologies: laser, armor, reduced signature, and others. He will probably also obtain a real psychological edge, especially from his much improved situational awareness.

The 2005-2025 Technologies. The years following the MOUT ACTD will see breakthrough technologies as well as improvements to MOUT technologies that will ultimately comprise the revolutionized Warfighter System.

This section will describe just some of those potentialities for 2005-2025. It is not by any means a complete list, as a complete list would be very long. The intent is to give a sense of the technologies that could be in store for the dismounted warfighter that would wreak extraordinary changes. Various research facilities in and out of the military are already pursuing a number of these technologies for various purposes. Many of the future technologies have widespread application; very few are peculiar to the military. A few "blue sky" or "stretch" technologies (not considered achievable by ~2025) will also be outlined here along with a few that do not fall into the Warfighter System definition. They are included because of the enormous impact they could have on the individual warfighter. Those technologies will be clearly indicated as "stretch" or not fitting the Warfighter System definition.

At this point, one might question why discussion centers on technologies emerging as early as 2005 if the revolutionized warfighter is a 2025 phenomenon. There are a few considerations for doing so. Some of the 2005-2020 potential technologies considered "do-able" or even being researched now may not hit their targeted time table for a number of reasons. It may also be reasonable to assume those technologies coming to fruition after 2005 or later may still offer the best to be had at 2025.

In any event, tight, precise predictions are obviously not possible. The best that can be done is to put forth possibilities with the caveat that unexpected technological breakthroughs are sure to occur, and the military will hopefully be watching for them and responding to them.

The taxonomy for the promising Warfighter System technologies will be the warfighter capabilities. In some cases the most appropriate category for a given technology may be arguable, but that just illustrates the synergy that can be gained by looking at the warrior as a system. For instance, improving the warrior's lethality is probably going to impact his survivability, just as improving his mobility may also improve his survivability.

Survivability

New "smart" materials will give new meaning to the words stealth and survivability and will have tremendous payoffs, especially for dispersed forces.

One example is a chameleon-like uniform material that renders the warfighter virtually invisible. Another is a ballistic material based on spider silk. This ballistic material will be inch-for-inch stronger than steel, but lighter than cotton, and will offer comfort and mobility along with survivability.

Chemical-biological protection from smart materials technology is also emerging. One possible technology is molecular imprinting. In this case a polymer membrane "traps" target molecules because they match the imprints of any molecules that have been made in it. The other is a gated membrane technology. A material embedded with this technology will breathe like regular clothing until a CB agent is detected, and

then the membrane will close off. With either technology the bulk of the current CB protective suit bulk will be a thing of the past, which will much improve the warfighter's comfort and mobility.[18]

Sensor technology will also play a large role in survivability. Embedded in clothing or other gear, sensors not only will be able to detect CB agents, they could also cancel the effects of body temperature, obscuring a battlefield signature. [19] They will also be able to monitor the location of the wearer and the enemy, and provide other battlefield intelligence. The notion would be to link all this information as appropriate.

A key sensor for improving survival is a bioanalysis system which will electronically relate real-time warrior status (e.g., vital signs, penetration from projectiles, blood loss) to a central monitoring site. [20]

One form of medical chemical-biological protection could be a reactive vaccine (administered after exposure) which would reverse or stop the damage by attacking and neutralizing the agent or by repairing the actual damage. [21]

Warfighters should be able to grow new organs from their own tissue thanks to advances in human genome mapping,[22] and a "stretch" will be replacement limbs fabricated of artificial tissues. [23] While those two technologies fall outside the Warrior System definition, they merit mention because of their import to the warfighter.

Sustainability

There will be considerable improvements in rations by 2020. For instance, food should be more concentrated and lighter,[24] and there could be a transdermal nutritional system. This system would be comprised of time-released nutriceutical substances

tailored to the an individual's needs which would go directly into his system through patches or lotions. The transdermal system will not truly substitute for food, but it will meet nutritional needs when food is not available.[25]

Bioprocessing will eventually revolutionize logistics and the warfighter's load. Warfighters will be able to create food, water, and ammunition components from substances locally available. The warfighter will no longer have to carry those items, or at least, not as many of them. He now can more rapidly maneuver and has the additional advantage of a reduced logistical footprint. This application of bioprocessing does not fall into the strict Soldier System definition but would alter the warfighter's life on the battlefield.

The generation of sustainment items will probably not become a reality in the 2020 timeframe, except for the water. It is possible that by 2020 an individual water purifier will be able to filter heavy metals, the only substances it can not filter today. The warfighter could then carry a small purifier or packet of chemicals instead of carrying water in those areas where water is available.

Command, Control, Communications, Computers, and Intelligence (C^4I)

This area is rife with possibilities. A single chip embedded in a warrior's clothing may be a whole miniature satellite communication system comprised of micromechanical devices that could be controlled by voice, gesture, or thought.[26]

Sensors will allow a warfighter to "see" through any weather, foliage and other obscurants as well as detect chemical and biological (CB) agents.[27] One distinct possibility for a CB sensor may come through micro-electro-mechanical-system

(MEMS) technology. MEMS could replace cumbersome $17,000 laboratory spectrometers which determine chemical composition of substances with a $20 device that the warfighter could hand carry.[28]

Biosensors may someday detect the presence, and maybe even the status, of enemy soldiers by detecting smells and other signatures. This capability is a "stretch, but breakthroughs by 2020 would be possible if enough resources are applied."[29]

Pharmaceutical enhancements could contribute to the warfighter's sense of being in control in battlefield situations. These pharmaceuticals could target specific areas of the brain and increase or extend cognitive, psychological, and physiological functions.

The warfighter's memory could improve along with his attention span. He could suffer less fear, less stress, and be more alert. He could be physically stronger and sleep better. He can deal with information overload and make better decisions. A "stretch" in performance enhancers would be those that would combat fatigue and hunger.[30]

Another "stretch" technology would be man-machine interfaces that would allow the warfighter to control equipment from afar with his or her mind. While this contention might evoke a chuckle, it is not as "blue sky" as it seems. Several automobile manufacturers are now trying to develop headrests that pick up signals from the driver's mind to control automotive functions.[31]

Advances in the traditional computing technologies will continue. For instance, computer systems will become much more user friendly, and can be smaller and lighter

as desired. Functions like voice activation will be commonplace. Information overload will also be tackled with "smart agent" computer applications.

However, a whole new computing technology, biocomputing, will bring unprecedented changes. Biocomputing is predicated on DNA-based storage and has widespread military applications. A DNA "chunk" the size of a sugar cube could hold 10 petabytes (10 million billion) of data. The individual soldier could have a small computer with billions of bytes of information, with everything from a complete language dictionary, to topographically accurate maps, to guides to the local flora and fauna if he is forced to live off the land.[32]

There are several other possible biotechnology applications to the future's integrated, complex C^4I systems. The "stretch" may be biocomputers which will also "lighten the load," as they would require minimal power.

Sensors could be linked with biocomputers which warfighters could instruct by consciously altering their brain waves or by voice or pattern recognition. At this point warfighters will be in a position to communicate more effectively with their machines through refinements in speech recognition, software, hardware, and research into a "warfighter language." [33]

Lethality

While the MOUT ACTD weapons technologies will presumably offer needed lethal and non-lethal contributions to the future warfighter, the development of precision indirect fires are definitely required because of the greater lethality they would offer. The indirect fire technologies do not fall into the definition of "Warfighter System," but

they would have a profound impact on the battlefield. The warfighter would have less weaponry and ammunition to carry, thus lightening the load, as well as much improved chances for target kill on the first attempt - a real psychological coup.

Anti-materiel weapons also have promise. They will feature agents that react in such a way to destroy the intended target, such as rubber-eating microbes, or microbes that consume silicon, electronics or Kevlar.

Genetically-designed weapons that are based on DNA of a target, such as genetic sequence of an enemy leader, or those that are targeted on a bodily function such as sight or motor ability, may eventually be considered. While these are ethically arguable and run counter to the Biological Weapons Convention, some maintain research will be needed to counter such weapons should enemy forces possess them.[34]

Mobility

New or improved airdrop technologies will allow for high tempo insertion of small units at many different locations, providing an edge in maneuver. There will be no time delays associated with personnel and equipment link-up. These technologies will also allow soft landings and a concomitant reduction in injuries.[35]

Discussion

Biotechnology. While the promising 2005-2025 technologies stem from a number of scientific disciplines, many are biotechnology applications. The

biotechnology field may offer some of the most spectacular applications the military could hope for. The "STAR - 21 Technology Forecast Assessments: Strategic Technologies for the Twenty-First Century" study cites numerous high payoff biotechnology areas[36] and the May 1996 "Biotechnology Workshop 2020" sponsored by the U.S. Army Research Laboratory (ARL) resulted in a prioritized list of 14 specific biotechnology research objectives.[37] The top nine have definite applications to the individual warfighter. They are (in ARL's priority order):

1. An "individual protection suite" for soldiers
2. Biosensors, and their associated transducers and actuators
3. A variety of human performance interventions
4. A "stealthy soldier suit" for camouflage and protection
5. An integrated microelectric bioanalysis (monitoring and diagnosis)
6. Understanding the correlations between neural information processing and human performance
7. Identification of pathogens targetable by DNA vaccination
8. DNA based materiel and personnel incapacitants
9. Assessment of the utility and implications of genetic weapons

While there are obstacles to attaining advances in future technologies, such as adequate funding, the interdependencies of breakthroughs, and ethical implications, some obstacles are especially pronounced in the biotechnology arena. For instance, improvements in biosensors depend on greater knowledge of neural nets, a complex

neuroscience area. The impact of pharmaceuticals on human performance has ethical overtones, and possibilities such as genetic weapons are laden with them. Nonetheless, the concern here is to report possibilities, and not dismiss a concept just because ethical or other considerations make the technology seem impractical today when it could spell something very different for tomorrow.

Sensors. Sensors will play a huge role in military life of the future and deserve specific mention. Unprecedented sensor technologies will arise from a number of scientific disciplines for the next 20 years. These sensors will have a multitude of capabilities; they will be able locate enemy positions or toxins, targets, explosives, nuclear activity, and personnel. Sensor data will come from space, unmanned aerial vehicles (UAV), air, ship, air, ground and the warrior himself. The radar, acoustic, biological, chemical, medical and other data garnered offer a myriad of possibilities for the conflict spectrum.

Conclusions

The future warfighter will be part of an elite, joint force which poses an expensive investment that cannot be easily replaced. The sheer economics involved in the training and sustainment of such a force dictate that these warriors must have the cutting edge warfighting tools and technologies if the military wants to optimize this strategic weapon and protect its investment.

The military should make the revolutionized warfighter the top priority of its future battlefield platforms. The Warfighter System will be a vital prerequisite to dominating maneuver and will also allow the military to meet urban warfare challenges. Since the dismounted warfighter has been, and will continue to be, the common denominator to the spectrum of conflict, it is an investment choice that can be made with utmost confidence.

Like traditional major acquisition programs, the Warrior System program must be funded, developed, and managed centrally, and programmatic oversight should reside at the highest organizational levels. Unlike traditional programs the Warfighter System poses unique considerations of doctrinal, psychological, personnel, training, and technological spheres, and, as such, needs special organizational structures and procedural. The program needs to be a variant of the standard acquisition process because of the urgent need to maintain the balance of its materiel and non-materiel aspects.

An overarching systems approach is required from the outset that can fuse all the Warfighter System's aspects - materiel and otherwise. The system's designers must carve out a long-range program showing a balanced approach and defined priorities. This will instill confidence of program success in the highest military levels and Congress and inspire adequate funding.

Today's decision makers have the hard task of making choices among the promising technologies. They cannot count on the desired technologies to arrive on the scene of their own accord. They must be aggressively pursued and funded accordingly.

They must assess these technologies in respect to their value in amplifying each warfighter's potential, and consider what the additive or multiplicative effects of these technologies might be as they incorporate them to the Warfighter System. A plus in the selection process is that most of the technologies go beyond the individual warfighter's needs; they have application to many battlefield platforms.

Recommendations

The first step toward the revolutionized warfighter should be to establish appropriate organizational structures and procedures. The developmental process will take over 20 years and the machinery must be able to withstand changes of personnel, be open to change and unforeseen technologies, and yet retain focus on an endstate. A high level program manager (major general or equivalent) should be appointed who reports directly to the U.S. Department of Defense Joint Staff, Office of Land and Littoral Warfare (J-8).

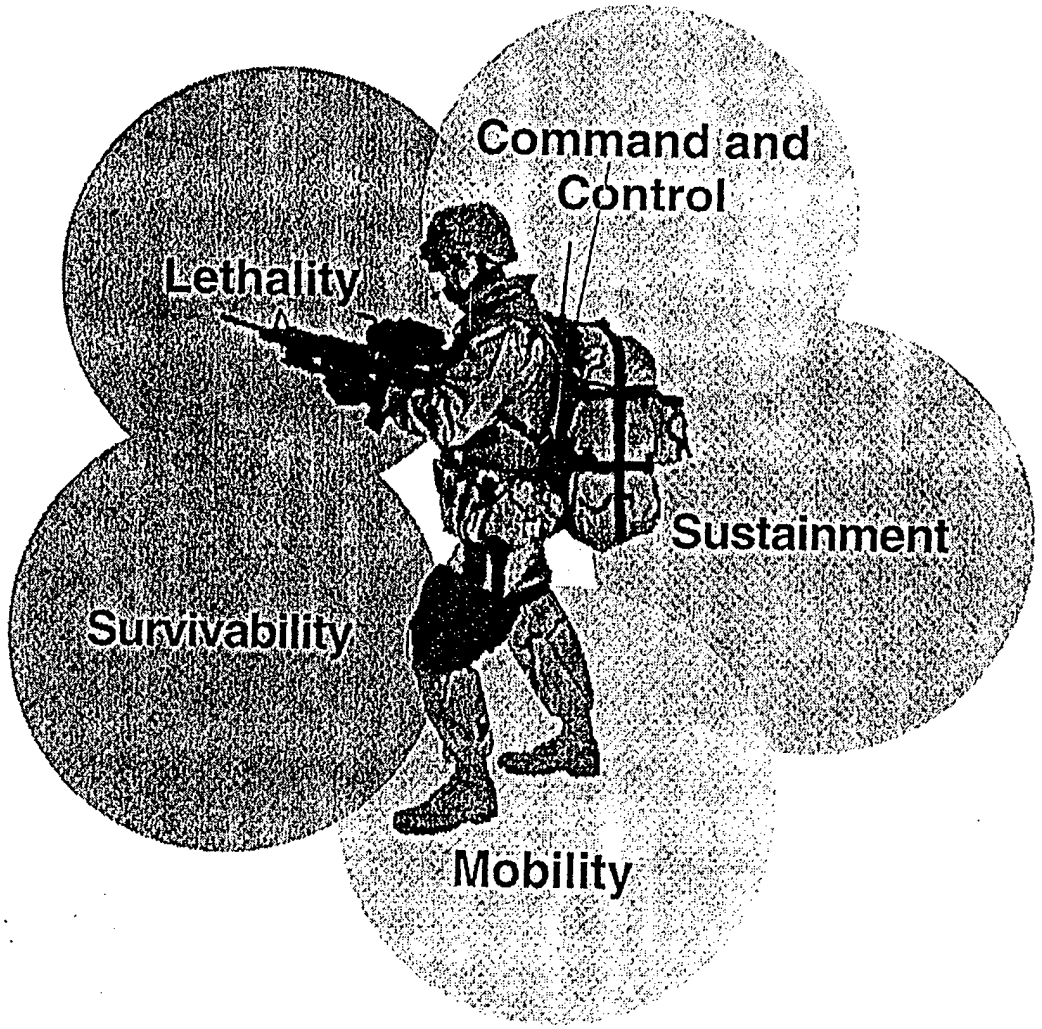
The first task for the manager will be to assemble the appropriate participants - technical, doctrinal, psychological and others - that cover all pertinent aspects of the system, but keep the group membership small enough to be productive. A key individual from each appropriate area should be assigned to the project full time for a designated period of time (perhaps a rotation of two years) and be a direct report to the program manager during that period. A revolutionized warfighter will not be realized if

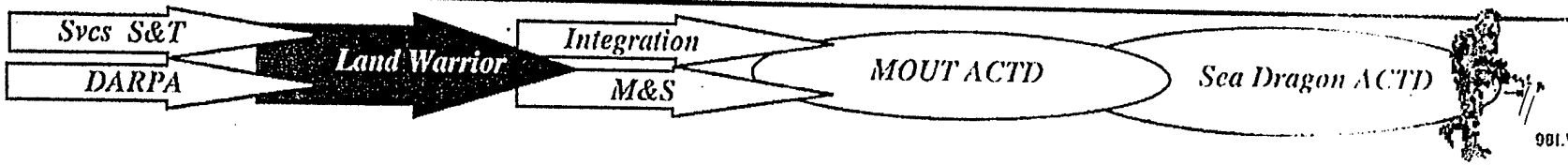
the program suffers the bureaucratic ills that tend to dilute programs and produce mediocre products.

The future's battlefield platforms should be built with the understanding that the Warfighter System is the core and centerpiece. Its technologies should be the first tier, or priority, and the second tier should be those technologies that do not fall into the core Warfighter System definition, but do have an impact apparent to him that seriously impacts his ability to wage war. These include technologies precision indirect fires, or breakthroughs that reduce logistical footprints. A third tier would be any technology that is transparent to the warfighter.

The C^4I arena is central to future warfare, and it must cater to the warfighter to be effective. Machines and technology must work for the human and not the other way around. The Warfighter System must be the starting point and define the optimal C^4I interfaces that capitalize on man and machine capabilities. To make the warfighter the end point rather than the starting point of the various battlefield platforms incorporating these technologies may result in the warfighter having to deal with a haphazard array of high-tech items that will not function well together and tax him cognitively and psychologically. This situation will not produce a revolutionized warfighter with a battlefield edge.

Enhanced Capabilities Through System Integration of Components





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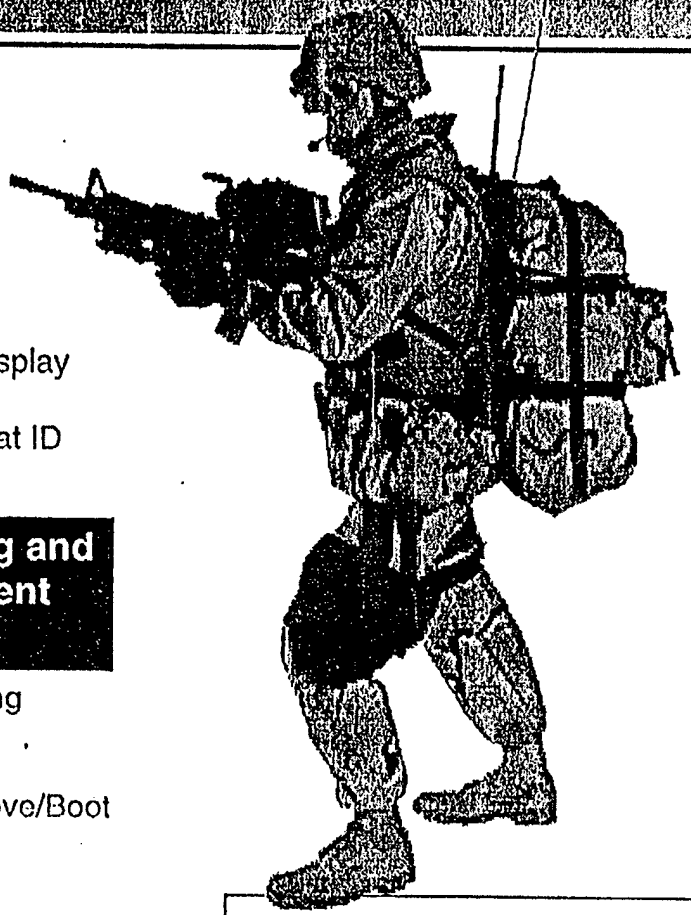
The Land Warrior System



Computer/Radio Subsystem

- Computer
- Soldier Radio
- Squad Radio
- GPS
- Handheld Flat Panel Display
- Video Capture
- Compatible With Combat ID Component

Protective Clothing and Individual Equipment Subsystem

- Advanced Load Carrying Capability
- Modular Body Armor
- ** Chem/Bio Garment/Glove/Boot
- * Other Existing CIE
- † Combat ID (PM-CID)

Software Subsystem

- Software
- * GFE Software

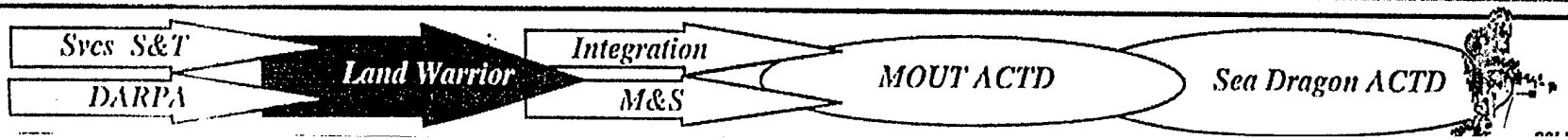
Integrated Helmet Assembly Subsystem (IHAS)

- Lightweight Helmet With Suspension
- Helmet-Mounted Display
- Image Intensifier (I^2) With Integrated Flat Panel Display
- Laser Detectors
- ** XM45 Chem/Bio Mask
- * Ballistic/Laser Eye Protection

Weapon Subsystem

- Laser Rangefinder
- Digital Compass
- Wiring Harness
- Video Camera
- ** Modular Weapon System
- ** Thermal Weapon Sight (TWS)
- ** Close Combat Optic
- * AN-PAQ4C - IR Laser Aiming Light
- * Other Existing Weapons & Accessories

BLACK	=	LW Development and Integrated Into LW by Contractor
RED**	=	GFE to K (Still Being Developed); Integrated Into LW System
GREEN*	=	GFE to K (Already Type Classified); Integrated Into LW System
BLUE†	=	Planned Product Improvement



Land Warrior Rear View (Assault Load Minus Butt Pack)

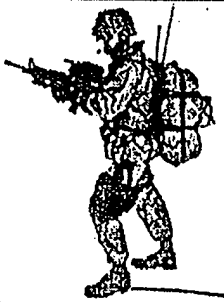
Svcs S&T
DARPA
Land Warrior
Integration
M&S
MOUT ACTD
Sea Dragon ACTD

THE ARMY PLAN
SOLDIER MODERNIZATION

1990

SIPE ATD

1992



Land Warrior

Helmet Mtd Display & Imp I²
Modular Weapon System
Integrated Protective CIE
Soldier/Squad Radio
GPS/Digitized Maps & Overlays

2000

Force XXI Land Warrior

HMD & Imaging System
Object Ind Combat Weapon
Multi-threat ballistic protection
GPS & Inertial navigation
Digitized maps & overlays
Microclimate Cooling

2004

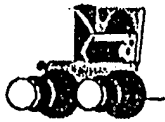
Force XXI

Analog to Digital

[26]

Current Soldier

PASGT Helmet
M16 A1/A2
Ballistic Protection
Chemcial Protection
Battledress Uniform (BDU)
Packs & Load Bearing Equip
Handwear & Footwear



Night Vision Devices
Thermal Weapon Sight
Laser Range Finder
Laser Aiming Device

HMD

Near-Real Time C²

Soldier's Computer

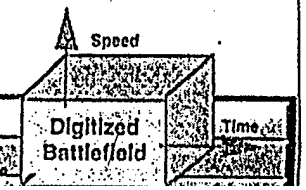
Miniaturization & Increased Integration

Soldier & Squad Radios

Stove Pipe System With No Integration of Small Arms, Protective Clothing & Equipment

Digitized Soldier Interdigital Data, Video, And Lifesign Communications

Maintain Decisive Edge Over Threat



Digitization of the Soldier System

Soldier Systems Potential for AAN
Land Warrior Consolidated Program

Provides:

- Digitization for the Dismounted Warrior
- Situational Awareness
- Target Acquisition and Automated Handover
- Improved Protection
- Enhanced Vision Capabilities

Subsystems:

- Computer Radio
- Integrated Helmet Assembly
- Weapon (Includes sight)
- Protective Clothing and Individual Equipment
- Software

Modular Integrated Fighting System for the Dismounted Warrior

ENDNOTES

[1] Office of the Secretary of Defense. Tactics and Technology for 21st Century Military Superiority: Final Report. (Washington: Defense Science Board, October 1996), Vol.1, II-5 - II-13.

[2] Douglas A. MacGregor, Breaking the Phalanx: A New Design for Landpower in the 21st Century. (Westport, CT: Prager Publications, 1997), 1-19.

[3] Philip Brandler, Acting Technical Director, Natick Research, Development and Engineering Center, "The Army After Next (AAN)," memorandum for Commander, U.S. Training and Doctrine Command, ATTN: ATCG-S (Dr. Paul Berenson), Fort Monroe, VA, 2 July 1996, para 2d.

[4] Ibid., para 2c.

[5] Tactics and Technology, V-12.

[6] Ibid., II-3 - II-9.

[7] Ibid., II-5.

[8] MacGregor, 59-93.

[9] Tactics and Technology, III-17 - III-20.

[10] A Fenner Milton, Briefing to MG Scales, Soldier Systems: The Path to the Army After Next (Washington, D.C.: Office of the Deputy Assistant Secretary for Research and Technology, 19 February, 1997), unnumbered page.

[11] Sean D. Naylor, "What the Future Holds...." Army Times, no. 34 (17 March, 1997): 22.

[12] Tactics and Technology, II-9.

[13] "Infantry System Turns Soldier Into High-Tech Urban Warrior," National Defense, Vol. LXXXI, April 1997, 24.

[14] Tactics and Technology, III-17.

[15] Ibid.

[16] Ibid., III-20.

[17] Memorandum, The Army After Next (AAN), para 2a.

[18] Ibid., para 2g.

[19] Steven Kenney et al., Biotechnology Workshop 2020, May 29-30, 1996: Summary Report. (McLean, VA: Science Applications International Corporation: SAIC Document no. 96-6963 &SAC., n.d.), 29.

[20] Memorandum, The Army After Next (AAN), para 2c.

[21] Science Applications International Corporation (SAIC), Biotechnology Workshop 2020: Readings, (McLean, VA: SAIC, December 1995), Tab H, 3.

[22] Joseph A. Engelbrecht, Jr. et al., Alternate Futures for 2025: Security Planning to Avoid Surprise. A research paper presented to Air Force 2025, April 1996, 153.

[23] Robert Langer and Joseph Vacanti, "Artificial Organs," Scientific American, (September 1995), Vol 273, no. 3, 131.

[24] Biotechnology Workshop 2020: Summary Report, 22.

[25] Memorandum, The Army After Next (AAN), para 2j.

[26] Engelbrecht, 181.

[27] Tactics and Technology, V-21.

[28] John Markoff, "New Wave in High Tech: Tiny Motors and Sensors," New York Times, 27 Jan 1997, p1.

[29] Biotechnology Workshop: Summary Report, 28.

[30] Ibid., 36.

[31] Biotechnology Workshop 2020: Readings, Tab H, 12.

[32] Ibid., Tab H, 8-9.

[33] Biotechnology Workshop: Summary Report, 29.

[34] Biotechnology Workshop 2020: Readings, Tab H,3.

[35] Memorandum, "The Army After Next (AAN) , par 2b.

[36] Biotechnology Workshop 2020: Readings, Tab H, 13.

[37] Biotechnology Workshop 2020: Summary Report, 1.

BIBLIOGRAPHY

Brandler, Philip, Acting Technical Director, Natick Research, Development, and Engineering Center. "The Army After Next (AAN)." Memorandum for Commander, U.S. Training and Doctrine Command, ATTN: ATCG-S (Dr. Paul Berenson), Fort Monroe, VA, 2 July 1996.

Dunnigan, James F. Digital Soldiers: The Evolution of High-Tech Weaponry and Tomorrow's Brave New Battlefield. New York: St. Martin's Press, 1996.

Engelbrecht, Joseph A., Jr. et al., Alternate Futures for 2025: Security Planning to Avoid Surprise. A Research Paper presented to Air Force 2025 April 1996.

Heinlein, Robert A. Starship Troopers. New York: Ace Books, 1987.

"Infantry System Turns Soldier Into High-Tech Urban Warrior," National Defense, Vol. LXXXI: April 1997

Kenney, Steven, Richard Love, Michael Wasserman, and Seth Weinberger. Biotechnology Workshop 2020, May 29-30, 1996: Summary Report. McLean, VA: Science Applications International Corporation (SAIC). SAIC Document no. 96-6963 &SAC. n.d.

Langer, Robert and Joseph Vacanti, "Artificial Organs," Scientific American, p. 131. September 1995 Vol 273, no. 3.

Logan, Robert R., A Complex Dragon in a Chaotic Sea: New Science for USMC Information Age Decisionmakers. Carlisle Barracks: U.S. Army War College, 29 March 1996.

Macgregor, Douglas A. Breaking the Phalanx: A New Design for Landpower in the 21st Century. Westport, CT: Praeger Publications, 1997.

Markoff, John. "New Wave in High Tech: Tiny Motors and Sensors." New York Times, 27 January, 1997, p.1.

Milton, A. Fenner, Soldier Systems: The Path to Army After Next. Washington, D.C.: Office of the Deputy Assistant Secretary for Research and Technology, 19 Feb 1997.

Naylor, Sean D., "What the Future Holds...." Army Times, no. 34 (17 March, 1997): 22.

O'Dawe, Nicholas P., Brief: The World in 2020. Fort Monroe, VA: Deputy Chief of Staff for Intelligence, U.S. Training and Doctrine Command, n.d.

Petersen, John L. The Road to 2015: Profiles of the Future. Corte Madera, CA: Waite Group Press, 1994.

Science Applications International Corporation (SAIC). Biotechnology Workshop 2020, May 29-30, 1996: Analytic Report SAIC Document no. 96-6968 &SAC, September 1996.

Science Applications International Corporation (SAIC). Biotechnology Workshop 2020: Readings. McLean, VA: SAIC, May 29-30, 1996.

Toffler, Alvin and Heidi Toffler. Creating a New Civilization: The Politics of the Third Wave. Atlanta: Turner Publishing Inc, 1995

Toffler, Alvin and Heidi Toffler. War and Antiwar. New York: Warner Books, Inc., 1995.

U.S. Army Training and Doctrine Command. Report on the Army After Next Project. Ft. Monroe, VA: U.S. Training and Doctrine Command, June 1996.

U.S. Department of Defense. Technology Area Review & Assessment (TARA): Infantryman Issues. Natick Research, Development and Engineering Center, 30 April - 3 May 1996.

U.S. Department of Defense. Tactics and Technology for 21st Century Military Superiority: Final Report, Vol 1. Washington, D.C.: Defense Science Board, October 1996.

U.S. Library of Congress. Domestic Trends to the Year 2015: Forecasts for the United States, ed. David L. Osborne. Washington, D.C.: Library of Congress, July 1991.

Weinberger, Caspar, and Peter Schweizer. The Next War. Washington: Regnery Publishing Inc, 1996.